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[Title of the Invention] IMAGE FORMING APPARATUS AND
IMAGE FORMING CONTROL METHOD

[Claims for the Patent]

5 [Claim 1]

An image forming apparatus that carries out image formation by primarily transferring an image produced by a laser beam method onto a rotatively driven image carrier and then secondarily transferring the image on 10 the image carrier onto a recording medium, characterized by comprising:

first issuing means that issues an image writing reference position signal for starting image formation based on a circumference that is a length of said image 15 carrier in a direction of rotation thereof;

second issuing means that issues the image writing reference position signal for starting image formation based on a detected reference position on the image carrier; and

20 selection means that selectively switches between signal issuing by said first issuing means and signal issuing by said second issuing means.

[Claim 2]

An image forming apparatus according to claim 1, 25 characterized by comprising reference position detecting means that detects the reference position on said image

carrier by detecting a marking attached to said image carrier, and in that

5 said first issuing means is operable when image formation is carried out with a plurality of colors, to determine image writing timing for a first color and issue the image writing reference position signal for the first color, and then determine image writing timing for a next color after a lapse of a time period corresponding to one rotation of said image carrier and issue the image 10 writing reference position signal for the next color, and

 said second issuing means is operable when image formation is carried out with the plurality of colors, to determine the image writing timing for the first color with reference to the reference position of said image 15 carrier detected by said reference position detecting means and issue the image writing reference position signal for the first color, and then determine the image writing timing for the next color with reference to the reference position of said image carrier redetected by 20 said reference position detecting means and issue the image writing reference position signal for the next color.

[Claim 3]

25 An image forming apparatus according to claim 1 or 2, characterized by comprising:

 reference clock generating means that generates a

reference clock signal; reference clock counting means that counts time with reference to one period of the reference clock signal as a unit time; circumference measuring means that measures the circumference of said 5 image carrier based on a time interval counted by said reference clock counting means based on the reference position detected by said reference position detecting means; storage means that stores the circumference measured by said circumference measuring means; and line 10 number counting means that counts a number of lines with reference to one period of a laser beam detect signal in a main scanning direction as one line period.

[Claim 4]

An image forming apparatus according to claim 3, 15 characterized in that the reference clock signal is a clock signal that has a time period at least less than the one line period.

[Claim 5]

An image forming apparatus according to claim 3, 20 characterized by comprising conversion means that converts a count value, which has been counted in units of the reference clock signal by said circumference measuring means, the count value corresponding to the circumference of one rotation of said image carrier, into 25 a number of lines, and in that said storage means stores the number of lines converted by said conversion means.

[Claim 6]

An image forming apparatus according to claim 5,
characterized in that said conversion means converts the
count value into the number of lines, by finely adjusting
5 an integer part of a conversion result in accordance with
a decimal part value of the conversion result, and said
storage means stores a value finely adjusted by said
conversion means.

[Claim 7]

10 An image forming apparatus according to claim 1 or 2,
characterized in that said first issuing means causes
said line number counting means to count the number of
lines stored in said storage means and determines issuing
timing of the image writing reference position signal for
15 the next color.

[Claim 8]

An image forming apparatus according to claim 3,
characterized in that said line number counting means
counts a predetermined number of lines corresponding to a
20 time period from issuing of the image writing reference
position signal for a final color to restart of conveying
for a recording medium from a recording medium standby
position located upstream of a position at which image
formation is carried out.

25 [Claim 9]

An image forming apparatus according to claim 1,

characterized in that said selection means selects the signal issuing by said second issuing means when a processing speed is changed during image formation, and selects the signal issuing by said first issuing means 5 when the processing speed is not changed during image formation.

[Claim 10]

An image forming apparatus according to any of claims 1 to 9, characterized in that the image forming 10 apparatus includes a copying machine, a multifunction apparatus, and a printer.

[Claim 11]

An image forming control method in an image forming apparatus that carries out image formation by primarily 15 transferring an image produced by a laser beam method onto a rotatively driven image carrier and then secondarily transferring the image on the image carrier onto a recording medium, characterized by comprising:

a first issuing step of issuing an image writing 20 reference position signal for starting image formation based on a circumference that is a length of the image carrier in a direction of rotation;

a second issuing step of issuing the image writing reference position signal for starting image formation 25 based on a detected reference position on the image carrier; and

a selection step of selectively switching between signal issuing in said first issuing step and signal issuing in said second issuing step.

[Claim 12]

5 An image forming control method according to claim 11, characterized by comprising a reference position detecting step of detecting the reference position on the image carrier by detecting a marking attached to the image carrier, and in that

10 when image formation is carried out with a plurality of colors, said first issuing step comprises determining image writing timing for a first color and issuing the image writing reference position signal for the first color, then determining image writing timing for a next color after a lapse of a time period corresponding to one rotation of the image carrier and issuing the image writing reference position signal for the next color, and

15 when image formation is carried out with the plurality of colors, said second issuing step comprises determining the image writing timing for the first color with reference to the reference position of the image carrier detected in said reference position detecting step and issuing the image writing reference position signal for the first color, and then determining the

20 image writing timing for the next color with reference to the reference position of the image carrier redetected in

25

said reference position detecting step and issuing the image writing reference position signal for the next color.

[Claim 13]

5 An image forming control method according to claim 11 or 12, characterized by comprising: a reference clock generating step of generating a reference clock signal; a reference clock counting step of counting time with reference to one period of the reference clock signal as 10 a unit time; a circumference measuring step of measuring the circumference of the image carrier based on a time interval counted in said reference clock counting step based on the reference position detected in said reference position detecting step;

15 a storage step of storing the circumference measured in said circumference measuring step; and

a line number counting step of counting a number of lines with reference to one period of a laser beam detect signal in a main scanning direction as one line period.

20 [Claim 14]

An image forming control method according to claim 13, characterized in that the reference clock signal is a clock signal that has a time period at least less than the one line period.

25 [Claim 15]

An image forming control method according to claim

13, characterized by comprising a conversion step of
converting a count value, which has been counted in units
of the reference clock signal in said circumference
measuring step, the count value corresponding to the
5 circumference of one rotation of the image carrier, into
a number of lines, and in that said storage step
comprises storing the number of lines converted in said
conversion step.

[Claim 16]

10 An image forming control method according to claim
15, characterized in that said conversion step comprises
converting the count value into the number of lines, by
finely adjusting an integer part of a conversion result
in accordance with a decimal part value of the conversion
15 result, and said storage step comprises storing a value
finely adjusted in said conversion step.

[Claim 17]

An image forming control method according to claim
11 or 12, characterized in that said first issuing step
20 comprises causing said line number counting step to count
the number of lines stored in said storage step and
determining issuing timing of the image writing reference
position signal for the next color.

[Claim 18]

25 An image forming control method according to claim
13, characterized in that said line number counting step

comprises counting a predetermined number of lines corresponding to a time period from issuing of the image writing reference position signal for a final color to restart of conveying for a recording medium from a 5 recording medium standby position located upstream of a position at which image formation is carried out.

[Claim 19]

An image forming control method according to claim 11, characterized in that said selection step comprises 10 selecting the signal issuing in said second issuing step when a processing speed is changed during image formation, and selecting the signal issuing in said first issuing step when the processing speed is not changed during image formation.

15 [Claim 20]

An image forming control method according to any of claims 11 to 19, characterized in that the image forming method is applied to an image forming apparatus including a copying machine, a multifunction apparatus and a 20 printer.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

The present invention relates to an image forming apparatus and an image forming control method that carry 25 out full-color image formation by primarily transferring

a toner image formed on a photosensitive drum onto an intermediate transfer member and secondarily transferring the toner image on the intermediate transfer member onto a recording medium.

5 [0002]

[Conventional Art]

Conventionally, there has been known an image forming apparatus that forms a full-color image by forming a latent image on a photosensitive drum according 10 to an electrophotographic method (laser beam method) and developing the latent image by causing toners to adhere to the latent image, then primarily transferring the toner images on the photosensitive drum onto an intermediate transfer member and secondarily transferring 15 the toner images on the intermediate transfer member onto a recording medium. An image forming apparatus of this type employs a technique which forms, in carrying out image formation on a recording medium such as thick paper or an OHP sheet, a full-color image by writing (by 20 exposing) toner images of the respective colors starting from a reference position on an image carrier (i.e., the photosensitive drum and the intermediate transfer medium) to thereby form the toner images on the image carrier. In this technique, the processing speed during image 25 formation is reduced, image formation is carried out with lines being reduced in number by an amount corresponding

to the drop in speed in a subscanning direction during exposure of the photosensitive drum, and toner images are transferred onto a recording medium and fixed thereon (for example, Patent Document 1).

5 [0003]

In the case that image formation for a reduced number of lines is carried out, such image formation can be convenient when the reduced processing speed is 1/2 or 1/4 of the normal processing speed, but when the reduced processing speed is 1/3 or 2/3 of the normal processing speed, there has been the problem that it is necessary to use, for example, complicated hardware circuits of a laser exposure device and the like that carries out exposure processing. To solve this problem, there has 10 been already developed a method that carries out an image forming process for forming toner images on an image carrier without changing the processing speed but changes the processing speed for carrying out processes including transferring toner images onto a recording medium and 15 subsequent processes (for example, Patent Document 2).

20 [0004]

[Patent Document 1]

Japanese Patent Laid-Open Publication (Kokai) No.

05-216323

25 [Patent Document 2]

Japanese Patent Laid-Open Publication (Kokai) No.

07-140845

[0005]

[Problems to be Solved by the Invention]

However, the above prior art has the following
5 problem. That is, when image formation is carried out by
the above conventional image forming apparatus on plain
paper or a like recording medium without changing the
processing speed, in the case where a marking or the like
that is formed in advance on an image carrier
10 (intermediate transfer member) is detected and the
detected position is used as a reference position (home
position) during image writing, there is the problem that
image writing cannot be started before the home position
is detected. As one solution, it can be envisaged that
15 the image carrier is stopped at a suitable position for
subsequent image formation after completion of post-
processing (processing such as cleaning off remaining
toner) that follows the completion of image formation.

[0006]

20 However, when the image carrier (intermediate
transfer member) is a belt-shaped member, the belt is
stretched over a plurality of rollers and rotatively
driven, which leads to deterioration of the material of
the belt due to tension. To avoid such deterioration, it
25 is not possible to stop the image carrier exactly at the
same position. Since it is thus not possible to always

stop the image carrier at the same suitable position following the post-processing mentioned above, time is required to detect the home position, depending on the position of the home position at the start of image formation, and the image formation can be only commenced after waiting for the time required for up to one full rotation of the image carrier at the maximum. This results in that an FCOT (First Copy Time) that is a period of time taken from the start of image formation (a process from charging to fixing with exposure, developing, and transferring in between) to discharging of a first recording medium for which image formation has been completed is excessively long.

[0007]

15 An object of the present invention, which has been made in view of the above problems, is to provide an image forming apparatus and an image forming control method that are capable of carrying out image formation performed for a recording medium such as plain paper 20 without deteriorating the FCOT and are also capable of carrying out optimal image formation performed for a recording medium, such as thick paper, for which the processing speed is reduced, with no registration misalignment between the leading ends of toner images and 25 the leading end of the recording medium.

[0008]

[Means for Solving the Problems]

To attain the above object, in an image forming apparatus that carries out image formation by primarily transferring an image produced by a laser beam method onto a rotatively driven image carrier and then secondarily transferring the image on the image carrier onto a recording medium, the present invention is characterized by comprising first issuing means that issues an image writing reference position signal for starting image formation based on a circumference that is a length of the image carrier in a direction of rotation thereof, second issuing means that issues the image writing reference position signal for starting image formation based on a detected reference position on the image carrier, and selection means that selectively switches between signal issuing by the first issuing means and signal issuing by the second issuing means.

[0009]

To attain the above object, in an image forming control method in an image forming apparatus that carries out image formation by primarily transferring an image produced by a laser beam method onto a rotatively driven image carrier and then secondarily transferring the image on the image carrier onto a recording medium, the present invention is characterized by comprising a first issuing step of issuing an image writing reference position

signal for starting image formation based on a circumference that is a length of the image carrier in a direction of rotation, a second issuing step of issuing the image writing reference position signal for starting 5 image formation based on a detected reference position on the image carrier, and a selection step of selectively switching between signal issuing in the first issuing step and signal issuing in the second issuing step.

[0010]

10 [Embodiments of the Invention]

Embodiments of the present invention will now be described in detail below with reference to the accompanying drawings.

[0011]

15 <Construction of Image Forming Apparatus and Image Forming Sequence>

FIG. 1 is a schematic diagram schematically showing the construction of an image forming apparatus according to the present embodiment. The image forming apparatus 20 is constructed as a copying machine that carries out full-color image formation using an electrophotographic method (laser beam method). This image forming apparatus is mainly comprised of a color reader section 1 including an original glass platen 101, an automatic original feeding device 102, a carriage 114, a carriage 115, a CCD (Charge Coupled Device) image sensor 111, a control unit

100, a digital image processing section 113, an external interface (I/F) section 116, and others, and a color printer section 2 including a laser scanner 201, a photosensitive drum 202, developing devices 203 for
5 respective colors, an intermediate transfer member 205, a secondary transfer roller 206, a fixing device 207, cassettes 208 to 211, a manual feed tray 240, a printer controller 250, various rollers, various flappers, and others.

10 [0012]

First, the respective constructions of component parts of the color reader section 1 of the image forming apparatus will be described. An original to be copied is automatically fed to an original reading position on an
15 upper surface of the original glass platen 101. The automatic original feeding device (auto document feeder or "ADF") 102 automatically feeds an original that has been set at an original stacking section, not shown, to the original reading position on the original glass platen 101. It should be noted that in place of the automatic original feeding device 102, it is possible to provide a mirrored pressing plate or a white pressing plate, not shown, at an upper part of the image forming apparatus, and, an original is manually placed at the
20 original reading position on the original glass platen 101, and the original is read while it is pressed by the
25

mirrored pressing plate or the white pressing plate.

[0013]

The carriage 114 accommodates light sources 103 and 104, reflective shades 105 and 106, and a mirror 107.

- 5 The light sources 103 and 104 illuminate the original and are implemented by, for example, halogen lamps, fluorescent lamps, xenon tube lamps, or the like. The reflective shades 105 and 106 converge the light emitted from the light sources 103 and 104 onto the original.
- 10 The mirror 107 reflects light reflected off the original to a mirror 108. The carriage 115 accommodates the mirror 108 and a mirror 109. The mirrors 108 and 109 reflect light from the mirror 107 towards a lens 110. It should be noted that a moving mechanism, not shown,
- 15 mechanically moves the carriage 114 at a speed v and the carriage 115 at a speed $v/2$ in a subscanning direction Y that is perpendicular to an electric scanning direction (main scanning direction X) of the CCD 111, to thereby scan the entire surface of the original.

20 [0014]

- 25 The lens 110 converges reflected light or projected light from the original that has passed via the mirrors 107 to 109 onto the CCD image sensor (hereinafter referred to as the "CCD") 111. The CCD 111 carries out a photoelectric conversion that converts reflected light or projected light from the original into an electric signal.

The CCD 111 is mounted on a substrate 112. The control unit 100 controls the entire image forming apparatus. The digital image processing section 113 is a printer processing section (reader/scanner controller) including component parts in a construction shown in FIG. 3, described later, excluding the CCD 111 and the external I/F section 116 (a clamp-and-amp-and-S/H-and-A/D section 502 to a page memory section 516). The external interface section 116 acts as an interface for external apparatuses (i.e., other devices).

10 [0015]

FIG. 2 is a block diagram showing the construction around the above-mentioned control unit 100 of the image forming apparatus. The control unit 100 includes a CPU 15 301 and a memory 302. In FIG. 2, reference numeral 113 designates a digital image processing section, 116 designates an external I/F section, 250 designates a printer controller, and 303 designates an operating section.

20 [0016]

The CPU 301 of the control unit 100 includes an interface that exchanges information with the digital image processing section 113 and the printer controller 250 to control these sections, and an interface that exchanges information with the operating section 303. The memory 302 stores programs executed by the CPU 301

and the like. The operating section 303 is comprised of a liquid crystal display with a touch panel, for example, so as to enable an operator to input instructions for causing the image forming apparatus to carry out

5 predetermined processing and to provide the operator with information, warnings, and the like relating to the processing of the image forming apparatus, and is provided on a housing of the image forming apparatus.

[0017]

10 FIG. 3 is a block diagram showing the detailed construction of the digital image processing section 113 of the image forming apparatus. The digital image processing section 113 includes the clamp-and-amp-and-S/H-and-A/D section 502, a shading section 503, a connection-and-MTF correction-original detecting section 504, an input masking section 505, a selector 506, a color space compression-and-background removal-and-LOG conversion section 507, a delay section 508, a moiré removing section 509, a magnification processing section 15 510, a UCR-and-masking-and-black character reflecting section 511, a γ correction section 512, a filter section 513, a background removal section 514, a black character determining section 515, and the page memory section 516. In FIG. 3, reference numeral 111 designates the CCD and 20 25 116 designates the external I/F section.

[0018]

The original on the original glass platen 101 reflects light emitted from the light sources 103 and 104 and the reflected light is guided via the mirrors 107 to 109 and the lens 110 to the CCD 111 where the light is 5 converted into an electric signal (analog image signal). Here, in the case where the CCD 111 is a color image sensor, the CCD 111 may be implemented by a single-line CCD where red (R), green (G), and blue (B) color filters are provided in a line in the order of red (R), green (G), 10 and blue (B) or by a three-line CCD where a red (R) filter, a green (G) filter, and a blue (B) filter are arranged on separate CCDs. The filters may be provided on a chip, or may be in separate bodies from the CCD 111.

[0019]

15 Next, the electric signal (analog image signal) mentioned above is inputted to the digital image processing section 113. In the clamp-and-amp-and-S/H-and-A/D section 502, the signal is sampled and held, a dark level of the analog image signal is clamped at a 20 reference potential, the signal is amplified to a predetermined level (the order in which these processes are carried out is not limited to the stated order), and the signal is subjected to an A/D conversion into eight-bit digital signals (RGB signals) for R, G, and B, for 25 example. Then, the digital signals (RGB signals) are subjected to shading correction and black correction by

the shading section 503. After this, in the connection-and-MTF correction-original detecting section 504, connection processing is carried out as follows in the case where the CCD 111 is a three-line CCD. That is, 5 since a reading position differs between the respective lines, delay amounts for the respective lines are adjusted in accordance with a reading speed to thereby correct timing for the signals so that the reading positions are the same for the three lines. Further, in 10 the connection-and-MTF correction-original detecting section 504, MTF correction is carried out to correct changes in an MTF for the reading due to the reading speed and magnification, and original detection processing is carried out to detect the size of the 15 original by scanning the original on the original glass platen 101.

[0020]

Next, the input masking section 505 corrects the digital signals thus having the reading position timing 20 corrected, for spectral characteristics of the CCD 111 and spectral characteristics of the light sources 103 and 104 and the reflective shades 105 and 106. Output signals from the input masking section 505 are inputted to the selector 506 that can switch between the signals 25 from the input masking section 505 and the external IF signals. The signals outputted from the selector 506 are

inputted to the color space compression-and-background removal-and-LOG conversion section 507 and the background removal section 514. Background removal correction is carried out on the signals inputted to the background removal section 514, and the resulting signals are inputted to the black character determining section 515 that determines whether characters in the original image are black characters, and generates a black character signal according to a result of reading the original.

5 [0021]

The color space compression-and-background removal-and-LOG conversion section 507 to which the output signals of the selector 506 have also been inputted, carries out color space compression processing by

15 determining whether the read image signals are within a range that can be reproduced by the color printer section 2 and outputting the input signals as they are when the signals are in this range or amending the signals so as to be within the range that can be reproduced by the

20 color printer section 2 when the signals are not in this range. Further, the color space compression-and-background removal-and-LOG conversion section 507 carries out background removal processing to convert the RGB signals to YMC signals. Then, to correct timing with

25 respect to the black character signal generated by the black character determining section 515, timing of the

output signals of the color space compression-and-background removal-and-LOG conversion section 507 are adjusted by the delay section 508. The moiré removing section 509 removes moiré from the two kinds of signals 5 outputted from the delay section 508 and the black character determining section 515, and the resulting signals are subjected to magnification/reduction processing in the main scanning direction by the magnification processing section 510.

10 [0022]

Then, the signals subjected to magnification/reduction carried out by the magnification processing section 510 are delivered to the UCR-and-masking-and-black character reflecting section 511, where 15 the signals are subjected to UCR processing to generate YMCK signals from the YMC signals, and then subjected to masking processing to correct the YMCK signals into suitable signals for output by the color printer section 2, and a determination result signal generated by the 20 black character determining section 515 mentioned above is fed back to the YMCK signals. The signals processed by the UCR-and-masking-and-black character reflecting section 511 are subjected to density adjustment by the γ correction section 512, and then subjected to smoothing processing or edge processing by the filter section 513. 25 The processed signals are stored in the page memory

section 516 and are outputted in image forming timing to the color printer section 2.

[0023]

Next, the configuration of each part of the color printer section 2 in the image forming apparatus will be described. Referring again to FIG. 1, the printer controller 250, which is disposed on the color printer section 2, receives control signals outputted from the CPU 301 inside the control unit 100 that is disposed in the color reader section 1 and controls the entire image forming apparatus. The control unit 100 causes the color reader section 1 to carry out image reading control as described above, temporarily stores read image data in the memory 302 inside the control unit 100, and operates in accordance with a reference timing signal from the printer controller 250 to transmit image data in the memory 302 as image data signals in timing synchronous with a video clock to the printer controller 250.

[0024]

The color printer section 2 operates as described below based on a control signal from the printer controller 250. The laser scanner 201 scans laser light corresponding to the image data signals in the main scanning direction using a polygon mirror so as to expose the photosensitive drum 202. With clockwise rotation of the photosensitive drum 202, a latent image thus formed

on the photosensitive drum 202 reaches a position facing a position of a developing sleeve surface of a four-color developing rotary for one color out of the four colors, the rotary being equipped with the developing devices 203 for respective colors. An amount of toner corresponding to the potential present between the surface of the photosensitive drum 202 on which the latent image has been formed and the developing sleeve surface to which a developing bias has been applied is jetted from one of 10 the developing devices 203 to the surface of the photosensitive drum 202 to develop the latent image on the surface of the photosensitive drum 202.

[0025]

Then, as the photosensitive drum 202 rotates in the 15 clockwise direction, the toner image thus formed on the surface of the photosensitive drum 202 is primarily transferred onto the intermediate transfer member 205 that rotates in a counterclockwise direction. In the case of black monochrome images, toner images are 20 sequentially formed and primarily transferred onto the intermediate transfer member 205 at predetermined time intervals. In the case of full-color images, latent images corresponding to the respective colors on the photosensitive drum 202 are developed by successively 25 positioning the images at the developing sleeve surfaces of the developing rotary for the respective colors and

the toner images on the photosensitive drum 202 are primarily transferred onto the intermediate transfer member 205. After four rotations of the intermediate transfer member 205, that is, when primary transfer has 5 been carried out for four colors, the primary transfer for a full-color image is completed.

[0026]

On the other hand, in the case of automatic feeding, a recording sheet is picked up from each cassette (an 10 upper cassette 208, a lower cassette 209, a third cassette 210, and a fourth cassette 211) by respective pickup rollers 212, 213, 214, and 215 provided for the each cassette and is conveyed by respective feed rollers 216, 217, 218, and 219 provided for the each cassette. 15 Then, the recording sheet is conveyed by vertical path conveying rollers 222, 223, 224, and 225 to a registration roller 221 where the recording sheet is put into a standby state. In the case of a manual feed, a recording sheet stacked on the manual feed tray 240 is 20 conveyed by a manual feed roller 220 to the registration roller 221 to be put into the standby state. After this, regardless of whether automatic feeding or manual feeding is performed, the recording sheet is conveyed to a space between the intermediate transfer member 205 and the 25 secondary transfer roller 206 in timing in which the primary transfer onto the intermediate transfer member

205 has been completed.

[0027]

Then, the recording sheet is conveyed towards the fixing device while it is held between the secondary transfer roller 206 and the intermediate transfer member 205 and is pressed onto the intermediate transfer member 205 so that the toner image on the intermediate transfer member 205 is secondarily transferred. The toner image transferred onto the recording sheet is fixed on the recording sheet through the application of heat and pressure by the fixing device 207 comprised of a fixing roller and a pressing roller. It should be noted that remaining toner on the intermediate transfer member 205 that is not transferred on the recording sheet and remains on the intermediate transfer member 205 is removed from the surface of the intermediate transfer member 205 by wiping away the remaining toner from the surface of the intermediate transfer member 205 by means of an intermediate transfer cleaning blade 230 disposed for contact with and separation from the surface of the intermediate transfer member 205, so that cleaning is performed by post-processing control in the latter half of an image forming sequence.

[0028]

Inside a photosensitive drum unit that includes the photosensitive drum 202, remaining toner is wiped away

from the surface of the photosensitive drum 202 by the cleaning blade 231 and is conveyed to a waste toner box 232 provided integrally in the photosensitive drum unit. In addition, other remaining toner with a positive or 5 negative polarity that is unexpectedly attached to the surface of the secondary transfer roller 206 can be attached to the intermediate transfer member 205 by alternately applying a secondary transfer forward bias and a secondary transfer reverse bias to the intermediate 10 transfer member 205. By wiping off the remaining toner with the intermediate transfer cleaning blade 230, the toner can be completely cleaned off, thereby completing the post-processing control.

[0029]

15 The recording sheet to which the image has been fixed is discharged according to any of a first discharging, a second discharging, and a third discharging. That is, in the case where the recording sheet is discharged according to the first discharging, a 20 first discharge flapper 237 is switched to the direction of a first discharge roller and the recording sheet is discharged towards the first discharge roller 233. In the case where the recording sheet is discharged according to the second discharging, the first discharge 25 flapper 237 and a second discharge flapper 238 are switched to the direction of a second discharge roller

and the recording sheet is discharged towards the second discharge roller 234. In the case where the recording sheet is discharged according to the third discharging, in order to have the recording sheet inverted by an 5 inverting roller 235, the first discharge flapper 237 and the second discharge flapper 238 are switched to the direction of the inverting roller 235 and the recording sheet is inverted by the inverting roller 235. After 10 inversion at the inverting roller 235, a third discharge flapper 241 is switched to the direction of a third discharge roller, and the recording sheet is discharged 15 towards the third discharge roller 236.

[0030]

In the case of double-sided discharging where the 15 recording sheet is discharged after images are formed on both sides, in the same way as the third discharging, a recording sheet that has had an image formed on a first side (one side) is inverted by the inverting roller 235 the third discharge flapper 241 is switched to the 20 direction of a two-sided unit, and the recording sheet is conveyed to the two-sided unit. Upon the lapse of a predetermined time period after a two-sided sensor has detected the recording sheet, conveying of the recording sheet is temporarily stopped, and when image preparations 25 are completed again, the recording sheet is refed to the space between the intermediate transfer member 205 and

the secondary transfer roller 206, and image formation is carried out on a second side (the other side) of the recording sheet. After this, the recording sheet on both sides of which image formation has been carried out is 5 discharged according to one of the first discharging, the second discharging, and the third discharging described above.

[0031]

<Image Formation using Result of Circumference
10 Detection for Intermediate Transfer Member>

FIG. 4 is a view schematically showing the construction of the intermediate transfer member 205 of the image forming apparatus. The intermediate transfer member 205 is formed of a belt-like member and has a marking 401 attached to an inner surface thereof which is used to determine a reference position (home position) 15 that is an image writing reference for the intermediate transfer member 205. Also, at a position slightly away from an inner surface of the intermediate transfer member 205, a marking-detection home position sensor 20 20 (hereinafter called "home position sensor" for short) 402 is disposed to detect an edge of the marking 401 attached to the intermediate transfer member 205.

[0032]

25 FIG. 5 is a block diagram schematically showing the construction of the printer controller 250 of the image

forming apparatus. The printer controller 250 is comprised of a printer section control CPU 601, an ASIC (Application Specific Integrated Circuit) 602, a ROM 603, a RAM 604, a communication interface 605, and a PIO (Parallel Input/Output) 606.

[0033]

The printer section control CPU 601 controls various component parts inside the printer controller 250 and also various component parts of the color printer section 2 based on control software stored in the ROM 603. The ASIC 602 has a function for realizing the main functions of the color printer section 2, and includes a counter and a register, not shown. The ROM 603 stores control software of the printer controller 250. The RAM 604 is used as a work memory for the control software of the printer controller 250. The communication interface 605 is an interface in charge of communication with the control unit 100 that controls the entire image forming apparatus. The PIO 606 is an I/O port for communication between the printer controller 250 and other control blocks.

[0034]

Next, an example of control in the image forming apparatus according to the present embodiment will be described with reference to FIGS. 4 to 9.

An edge detection signal obtained by edge detection

for the marking 401 on the intermediate transfer member 205 by the home position sensor 402 shown in FIG. 4 (step S1), is inputted to the printer section control CPU 601 shown in FIG. 5 as an interrupt signal and is also 5 inputted to the ASIC 602. When the edge detection signal is inputted to the ASIC 602, a counter, not shown, inside the ASIC 602 that counts reference clock signals generated inside the ASIC 602 within a IBD (Beam Detect: a laser beam detection signal in the main scanning 10 direction) period is activated (step S2), and the count value of reference clock signals is latched in a specified register, not shown, upon input of the next edge detection signal.

[0035]

15 In the case where only one marking 401 is attached to the intermediate transfer member 205, at a time point when the marking 401 is detected again following one detection of the marking 401 by the home position sensor 402, the circumference, i.e., the length in the 20 circumferential direction, of the intermediate transfer member 205 is detected by the ASIC 602 (step S3). In the case where a plurality of markings 401 are attached to the intermediate transfer member 205, at a time point when a number of markings 401 corresponding to one 25 rotation of the intermediate transfer member 205 have been detected, the circumference of the intermediate

transfer member 205 is detected by the ASIC 602 by accumulating the count number latched in the register (step S3). The printer section control CPU 601 calculates a count value, which is counted for every 5 reference clock signal and latched and corresponds to the circumference of the intermediate transfer member 205, per IBD period.

[0036]

Here, the reference clock signals are issued by the 10 ASIC 602 as a reference for counting, and have a duration that is set to a duration at least less than one line period. One period of the reference clock signal is set as one unit time, and a desired time period is counted by a counter, not shown, of the ASIC 602 in units of the 15 reference clock signals.

[0037]

FIG. 6 is a timing chart showing the timing relationship between the reference clock signal and the 20 IBD period signal, FIG. 7 is a timing chart showing a BD period signal when detecting intermediate transfer member reference position in the case of detecting the circumference of the intermediate transfer member 205, and FIG. 8 is a timing chart showing the timing of 25 issuing of an image writing reference position signal when correction control is provided for the detection of the circumference of the intermediate transfer member 205.

The example shown in FIG. 6 shows that approximately 5.5 reference clock periods is equal to 1BD period. Using this relationship, the printer section control CPU 601 converts the count value latched in the register of the 5 ASIC 602 into a count value in units of 1BD period (i.e., single line) (step S4). An integer part of the count value resulting from the conversion is then finely adjusted in accordance with a decimal part of the converted count value obtained at the same time (step S5).
10 [0038]

In the case where there is only one marking 401 attached to the intermediate transfer member 205 as shown in FIG. 4, in detection of the circumference of the intermediate transfer member 205, the marking 401 15 (intermediate transfer member reference position) is not always detected in timing corresponding to an integer multiple of the period of the BD period signal as shown in FIG. 7, and therefore the integer part of the count value obtained by the conversion described above needs to be finely adjusted by adding "+1", "+0", or "-1" 20 depending on the value of the decimal part obtained by the same calculation.

[0039]

In the ASIC 602 of the present embodiment, after an 25 image writing reference position signal for a first color (Y) on the intermediate transfer member 205 has been

issued, once the count value after the fine adjustment has been set in a setting register (step S6), a number of BD period signals with respect to the set count value are counted, and after the counting an image writing 5 reference position signal for the next color is issued (step S7) (see FIG. 8). It should be noted that in FIG. 8, symbol "ITB" designates the intermediate transfer member (belt), and symbols "Y-TOP", "M-TOP", "C-TOP", and "K-TOP" designate the image writing reference position 10 signals for the respective colors, yellow, magenta, cyan, and black. The image writing reference position signal issuing function for the respective colors of the ASIC 602 is used to detect in advance the circumference of the intermediate transfer member 205, the count value counted 15 in units of reference clock signals is converted into units of 1BD period, the conversion result is stored in a memory such as the RAM 604, and during image formation the conversion result stored in the memory is set so that it is possible to form full-color images regardless of 20 the marking position on the intermediate transfer member 205.

[0040]

<Image Formation using Reference Position obtained
by Detection of Marking Position on Intermediate Transfer
25 Member>

In the image forming apparatus according to the

present embodiment, by detecting the edge of the marking 401 of the intermediate transfer member 205 as described above once per rotation of the intermediate transfer member 205 for a total of four rotations corresponding to 5 four colors, and inputting an interrupt signal to the printer section control CPU 601 when the marking edge is detected, to cause the ASIC 602 to issue image writing reference position signals for the respective colors, yellow, magenta, cyan, and black, it is possible to form 10 an image with no registration misalignment between leading ends of toner images and the leading end of the recording sheet.

[0041]

In the image forming apparatus according to the 15 present embodiment, in order to correctly carry out image formation with no registration misalignment between the leading ends of the toner images and the leading end of the recording sheet, registration roller release timing ("registration ON timing") in which the recording sheet 20 is released from the registration roller 221 (i.e., the recording sheet is released from the standby state and conveying is recommenced) is used such that a number of lines corresponding to a time period from issuing of a toner image writing reference position signal for the 25 final color to the registration roller release timing (the registration ON timing) is set in the ASIC 602. In

the ASIC 602, the set line number value is counted in units of BD period signals. By thus counting BD signals that are very accurate, the registration ON timing is accurately determined.

5 [0042]

In the registration ON timing, the ASIC 602 inputs an interrupt signal to the printer section control CPU 601. Upon receiving the interrupt signal in the registration ON timing, the printer section control CPU 10 601 releases the registration roller 221 from a registration roller position at which the registration roller 221 has been temporarily stopped for skew correction (a correction operation for skewing of the recording sheet by having a leading end of the recording 15 sheet abutting on the registration roller 221) to start refeeding of the recording sheet, thereby realizing optimal secondary transfer control.

[0043]

In carrying out image formation on a recording sheet 20 such as thick paper and an OHP sheet, an image forming operation is carried out at a processing speed of 1/1 up to image formation on the intermediate transfer member 205 (primary transfer) and the fixing speed is reduced when the secondary transfer onto the recording sheet and 25 fixing are carried out. By doing so, in the image forming apparatus according to the present embodiment,

image formation onto the intermediate transfer member 205 is carried out at the processing speed of 1/1, which can dispense with a complicated hardware construction for thinning out image data in laser-exposing the 5 photosensitive drum 202.

[0044]

However, since essentially correct registration ON is realized by determining the registration ON timing based on the image writing reference positions, if a 10 motor speed reducing process is carried out to lower the processing speed during the image forming process at the secondary transfer and subsequent steps, it is difficult to grasp time due to the motor speed reducing process, so that the registration ON timing cannot be correctly set 15 based on the timing of issuing of the toner image writing reference position signals.

[0045]

Thus, in the image forming apparatus according to the present embodiment, image formation is carried out 20 using the reference position of the intermediate transfer member 205. Specifically, when image formation is carried out on a recording sheet such as thick paper or an OHP sheet, toner image formation is carried out with edge detection of the marking 401 on the intermediate 25 transfer member 205 as a reference for image writing, and the edge of the marking 401 is redetected after the

processing speed has been reduced. By doing so, the correct toner image top or leading end position can be found even after the processing speed has been reduced, so that the secondary transfer and fixing control can be 5 optimally carried out with no registration misalignment between the leading ends of the toner images and the leading end of the recording sheet.

[0046]

Here, the operating section 303 of the image forming 10 apparatus can freely select an image forming method out of "image formation using the detected circumference of the intermediate transfer member 205" described above and "image formation using the reference position found by detecting the marking position on the intermediate 15 transfer member 205" described above. "Image formation using the reference position found by detecting the marking position on the intermediate transfer member 205" can be selected by the operating section 303 of the image forming apparatus in the case where the processing speed 20 is changed during image formation, while "image formation using the detected circumference of the intermediate transfer member 205" can be selected in the case where the processing speed is not changed during image formation. Based on such setting from the operating 25 section 303, the ASIC 602 carries out the control described above under the control of the printer section

control CPU 601.

[0047]

As described above, according to the present embodiment, in the image forming apparatus in which image formation is carried out by primarily transferring a toner image on the photosensitive drum 202 onto the intermediate transfer member 205 and then secondarily transferring the toner image on the intermediate transfer member 205 onto the recording sheet, the ASIC 602 of the printer controller 250 selectively switches, based on a setting from the operating section 303, between (i) image formation carried out by issuing an image writing reference position signal for starting image formation based on the circumference of the intermediate transfer member 205 (image formation using the detected circumference of the intermediate transfer member 205) and (ii) image formation carried out by issuing an image writing reference position signal for starting image formation based on a detected reference position on the intermediate transfer member 205 (image formation using a reference position found by detecting a marking position on the intermediate transfer member 205).

[0048]

As a result, it is possible to provide an image forming apparatus that can carry out image formation on plain paper without deteriorating the FCOT (First Copy

Time), i.e., a time period from the start of image formation (processing from charging to fixing with exposure, developing, and transferring in between) to discharging of a first recording sheet for which image formation has been completed, and can also carry out optimal image formation on a recording sheet, such as thick paper, for which the processing speed is reduced, with no registration misalignment between the leading end of the toner image and the leading end of the recording sheet.

[0049]

[Other Embodiments]

The present invention is not limited to the above described embodiment and can be applied to any other construction that can achieve the functions described in the appended claims or the functions of the construction of the above described embodiment.

[0050]

Although the above embodiment is configured such that any one image forming method is selected out of "image formation using the detected circumference of the intermediate transfer member 205" and "image formation using a reference position by detecting a marking position on the intermediate transfer member 205", a variety of selecting methods, for example, a method where the former image forming method may be carried out in the

case where an instruction not to change the processing speed during image formation has been received from the operating section 303 and the latter image forming method may be carried out in the case where an instruction to 5 change the processing speed during image formation has been received from the operating section 303, or another method where dedicated keys corresponding respectively to the former and latter image forming methods may be provided on the operating section 303, and when a 10 pertinent key is pressed, the image forming method corresponding to the key may be carried out, may be envisaged.

[0051]

Although the above described embodiment is directed 15 to an example where the printer controller 250 of the image forming apparatus has the construction shown in FIG. 5, the present invention is not limited to this construction. For example, instead of providing the CPU 601 and the ASIC 602 separately, other constructions, 20 such as a construction with a single block having the functions of the CPU 601 and the ASIC 602, may be used as desired without departing from the scope of the present invention.

[0052]

25 Also, although the above described embodiment is directed to an example where the image forming apparatus

is a copying machine that carries out image formation using the electrophotographic method, the present invention is not limited to this and can be applied to a multifunction apparatus or a printer that carries out 5 image formation according to the electrophotographic method.

[0053]

It is to be understood that the object of the present invention may also be accomplished by supplying a 10 system or an apparatus with a storage medium in which a program code of software which realizes the functions of the above described embodiment is stored, and causing a computer (or CPU or MPU) of the system or apparatus to read out and execute the program code stored in the 15 storage medium.

[0054]

In this case, the program code itself read out from the storage medium realizes the functions of the embodiment described above, and hence the program code 20 and the storage medium in which the program code is stored constitute the present invention.

[0055]

Examples of the storage medium for supplying the program code include a floppy (registered trademark) disk, 25 a hard disk, a magneto-optical disk, a CD-ROM, a CD-R, a CD-RW, a DVD-ROM, a DVD-RAM, a DVD-RW, a DVD+RW, a

magnetic tape, a nonvolatile memory card, a ROM, and the like.

[0056]

Further, it is to be understood that the functions of the above described embodiment may be accomplished not only by executing a program code read out by a computer, but also by causing an OS (operating system) or the like which operates on the computer to perform a part or all of the actual operations based on instructions of the program code.

[0057]

Further, it is to be understood that the functions of the above described embodiment may be accomplished by writing a program code read out from the storage medium, into a memory provided on an expansion board inserted into a computer or in an expansion unit connected to the computer and then causing a CPU or the like provided in the expansion board or the expansion unit to perform a part or all of the actual operations based on instructions of the program code.

[0058]

[Advantages of the Invention]

As described above, according to the present invention, selective switching is carried out between signal issuing by the first issuing means that issues an image writing reference position signal for starting

image formation based on a circumference that is a length of the image carrier in a direction of rotation thereof, and signal issuing by the second issuing means that issues the image writing reference position signal for 5 starting image formation based on a detected reference position on the image carrier, thereby there can be provided an image forming apparatus by which, in the case of image formation on a recording medium such as plain paper, the image formation can be carried out without 10 deteriorating the FCOT (First Copy Type) as a time period from the start of image formation (processing from charging to fixing with exposure, developing, and transferring in between) to discharging of a first recording medium on which image formation has been 15 subjected, and in the case of the image formation on a recording medium, such as thick paper, for which the processing speed is reduced, it is also possible to carry out optimal image formation with no registration misalignment between the leading ends of toner images and 20 the leading end of the recording medium.

[Brief Description of the Drawings]

[FIG. 1]

A schematic diagram schematically showing the construction of an image forming apparatus according to 25 an embodiment of the present invention.

[FIG. 2]

A block diagram showing the construction around a control unit of the image forming apparatus.

[FIG. 3]

5 A block diagram showing the detailed construction of a digital image processing section that forms a part of the control unit.

[FIG. 4]

10 A view schematically showing the construction of an intermediate transfer member of the image forming apparatus.

[FIG. 5]

15 A block diagram schematically showing the construction of a printer controller of the image forming apparatus.

15 [FIG. 6]

A timing chart showing the timing relationship between 1BD period and a reference clock signal period.

[FIG. 7]

20 A timing chart showing a BD period signal when detecting intermediate transfer member reference position in the case of detecting the circumference of the intermediate transfer member.

[FIG. 8]

25 FIG. 8 is a timing chart showing the timing of issuing of an image writing reference position signal when correction control is provided for the detection of

the circumference of the intermediate transfer member.

[FIG. 9]

FIG. 9 is a flowchart schematically showing an example of control in the image forming apparatus.

5 [Description of Reference Numerals]

1 color reader section

2 color printer section

100 control unit

111 CCD

10 202 photosensitive drum

203 developing devices for respective colors

205 intermediate transfer member (image carrier)

206 secondary transfer roller

221 registration roller (recording medium standby

15 position located upstream of a position at which image formation is carried out.)

250 printer controller

303 operating section (selection means)

401 marking

20 402 home position sensor (reference position detecting means)

601 printer section control CPU (selection means, line number counting means, conversion means)

602 ASIC (first issuing means, second issuing means,

25 reference clock generating means, reference clock counting means, circumference measuring means)

604 RAM (storage means)

[Name of Document] ABSTRACT

[Abstract]

[Problem to be solved]

To make it possible to carry out image formation for
5 a recording medium such as plain paper without
deteriorating the FCOT and to carry out optimal image
formation for a recording medium, such as thick paper,
for which the processing speed is reduced with no
registration misalignment between the leading ends of
10 toner images and the leading end of the recording medium.

[Solution]

In an image forming apparatus that carries out image
formation by primarily transferring a toner image on a
photosensitive drum onto a intermediate transfer member
15 205 and then secondarily transferring the toner image on
the intermediate transfer member onto a recording medium,
an ASIC 602 of a printer controller 250 selectively
switches, based on a setting from an operating section
303, between controlling for issuing an image writing
20 reference position signal for starting image formation
based on the circumference of the intermediate transfer
member 205 and controlling for issuing the image writing
reference position signal for starting image formation
based on the detected reference position on the
25 intermediate transfer member 205.

[Selected Drawing] FIG. 2

FIG. 1

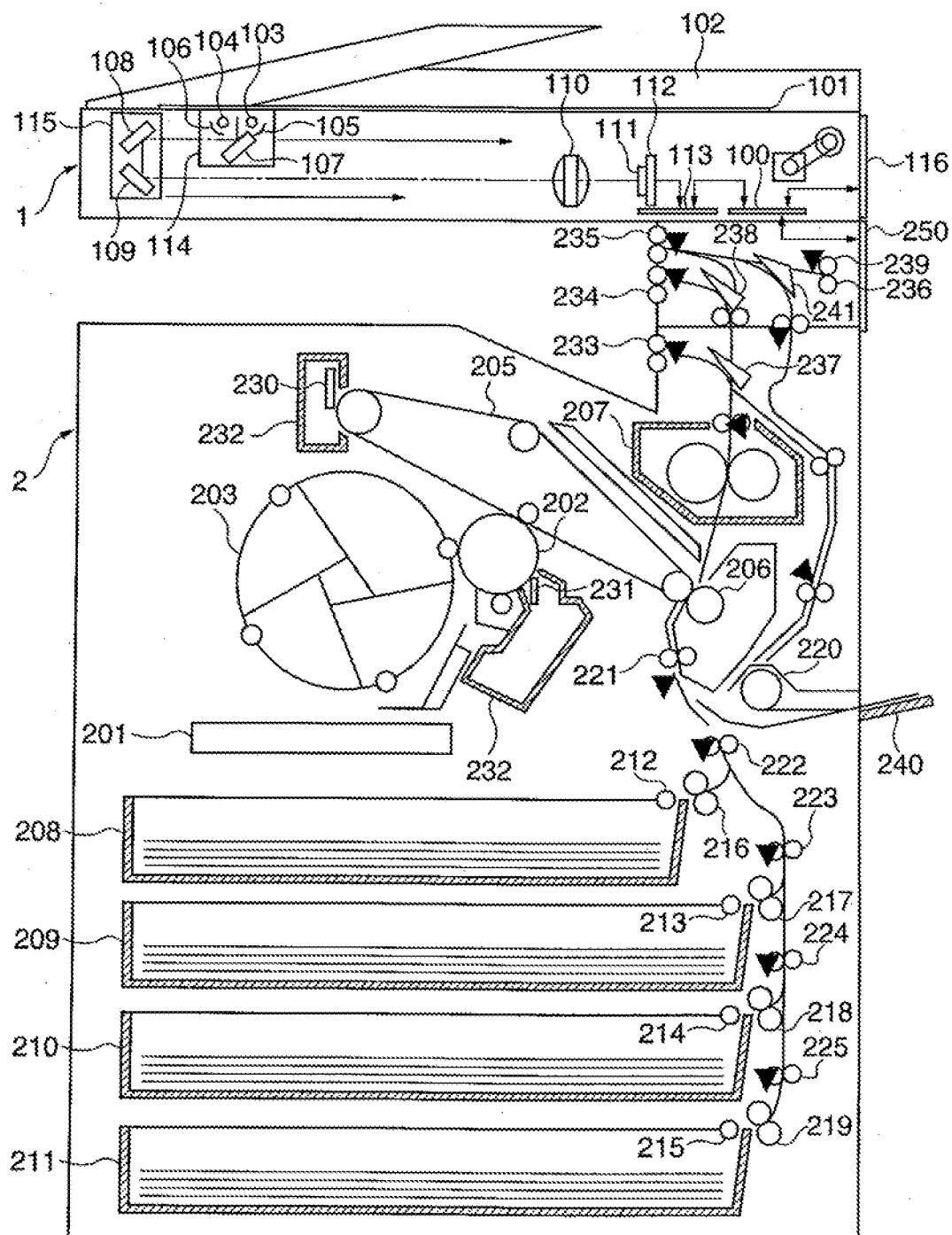


FIG. 2

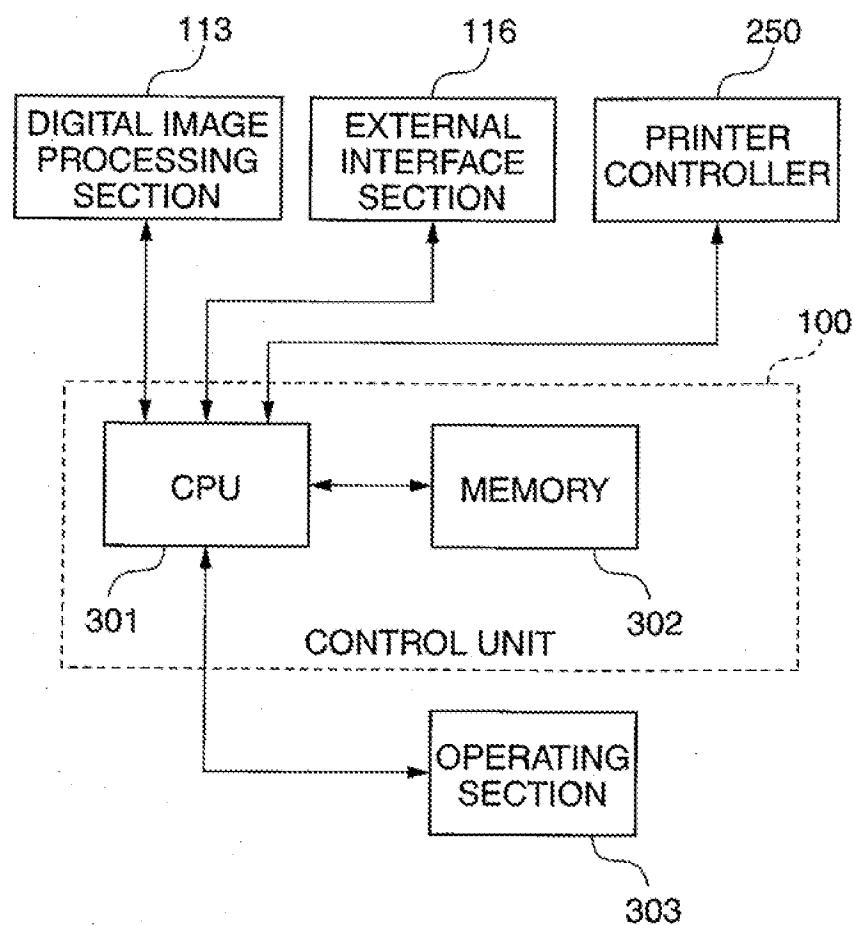


FIG.3

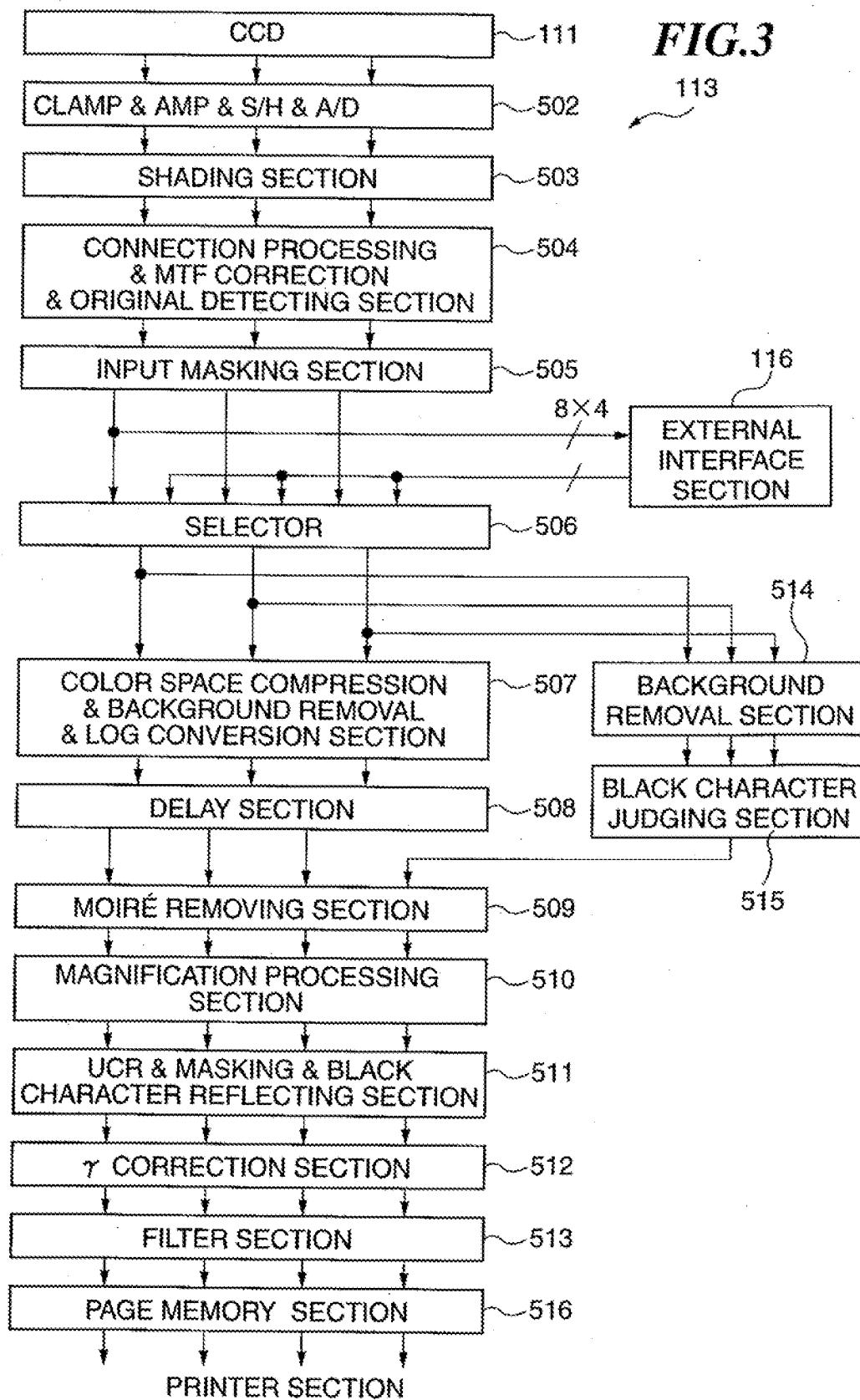


FIG. 4

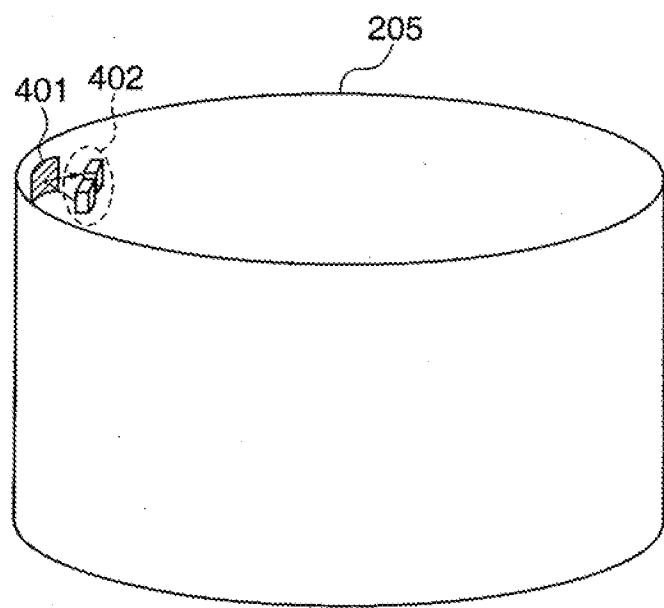


FIG. 5

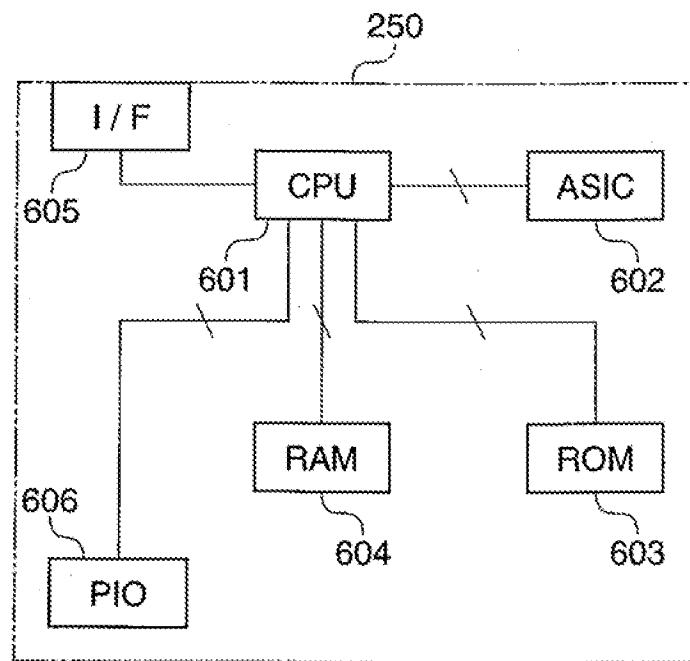


FIG. 6

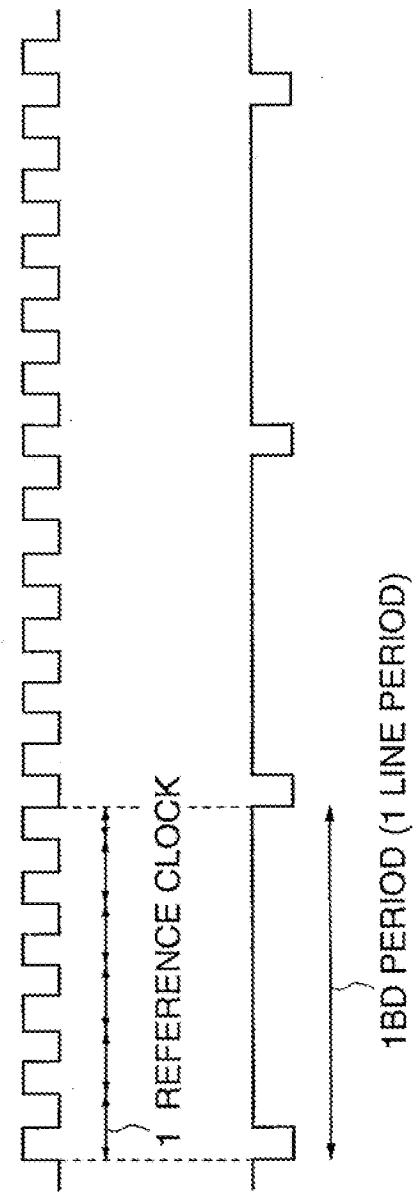


FIG. 7

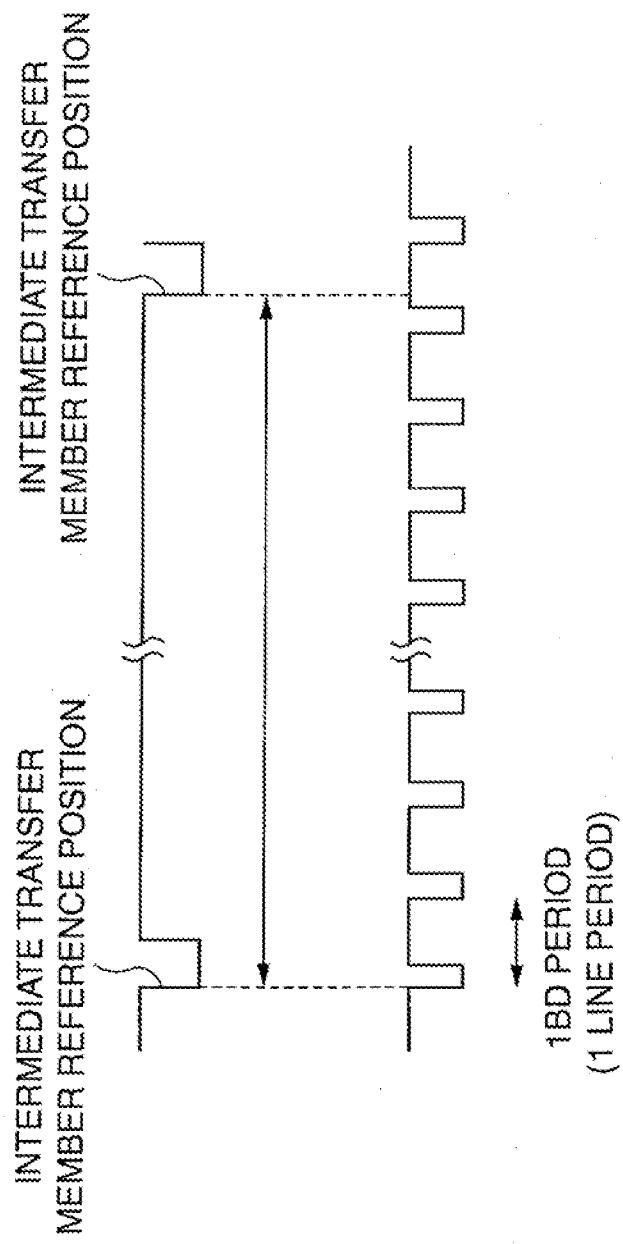


FIG. 8

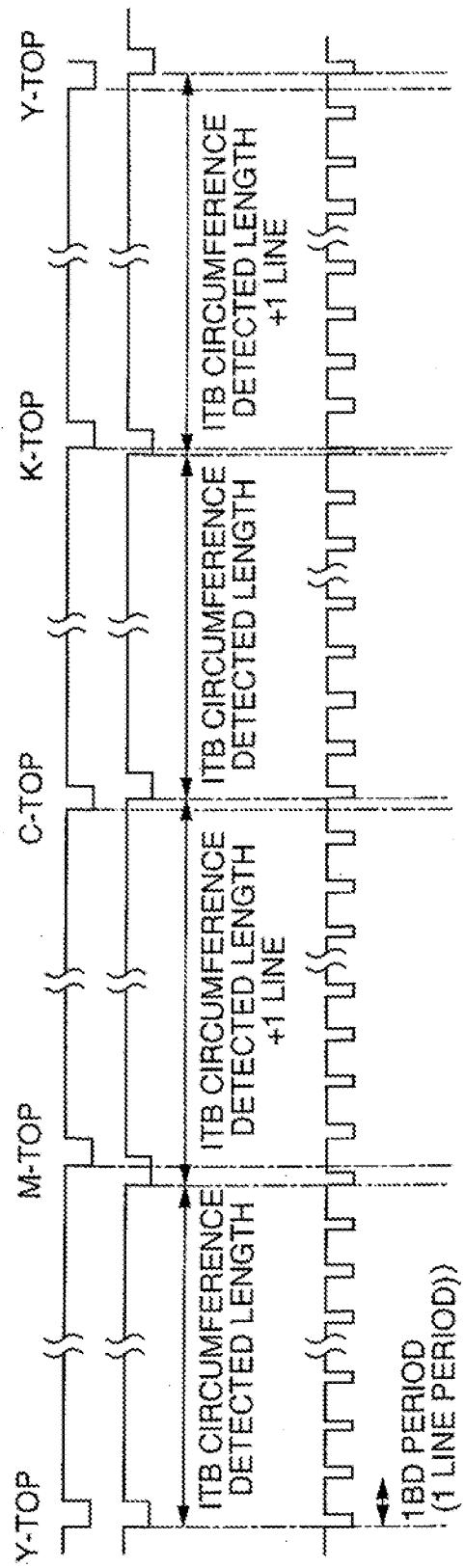


FIG. 9

